High-precision combat elements

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The creation of high-precision ammunition operating on the "fire-and-forget" principle is one of the directions of improving the arsenal of artillery ammunition. Such ammunition, equipped with homing systems, must ensure high efficiency of destruction of tanks and other armored vehicles. An important feature of the technical policy in the creation of these weapons was the development of modular unified blocks of cluster homing and self-aiming warheads, with which not only artillery shells are equipped, but also the warheads of operational-tactical missiles, MLRS missiles, as well as guided and unguided aviation containers.

Self-aiming combat elements (SPBE) search and detect an object during descent with simultaneous rotation, after aiming a warhead, a self-forming striking element (such as a "shock core") is shot. Self-aiming ammunition is optimized for hitting very specific targets (armored vehicles), and is practically ineffective for other combat applications.

The most important moment in the self-aiming process of an intelligent ammunition is the operation of its onboard sensors (including accompanying algorithms). The system of on-board sensors should not only be able to detect camouflaged targets in the face of enemy countermeasures on all types of terrain (land, water surface), in different climatic zones, but also "be able" to distinguish a heavy tank to be destroyed from similar military objects (lightly armored vehicles , metal hulls of decommissioned ships, decoys, "trap" objects). This problem is usually solved by combining sensors, the operation of which is based on different physical principles.

This article presents six of the most famous high-precision combat elements:

- TGSM
- BAT
- SADARM
- BONUS
- ACED
- SMArt

TGSM

The TGSM-type homing warhead is being developed as part of the MLRS / TGW (Multiple Launch Rocket System / Terminally Guided Warhead) program launched in 1984 by an international consortium that includes Martin Marietta (USA), Diehl (Germany), " Thomson - CSF "(France) and" Thorn - EMI "(Great Britain). It is designed to equip the NURS warhead (unguided missile) MLRS MLRS.

The NURS cassette warhead contains three homing combat elements (BE), each of which has a shaped charge, a radar homing head operating in the millimeter wavelength range, and a control mechanism.

The TGSM was also intended to equip the "Block-2" mod.2 cluster warhead under development for OTR ATACMS. As a competitor, the IRTGSM element with a passive infrared seeker was developed. However, these works were suspended at the beginning of 1991 and, according to some experts, are unlikely to be continued. At present, the BAT element is supposed to be used to equip the Block-2 mod.2 cluster warhead.

In July 1989, the demonstration phase began and ended in March 1993. The test program provided for the following activities: layout of the TGW warhead; the release of a number of NURS with a warhead fully equipped with homing warheads; additional tests of the seeker; dropping ammunition in a combat version; general assessment of the possibility of producing weapons. This should be followed by a full development phase of 29 months.

In mid-1991, the US Department of Defense announced the existence of a program to develop a stealth missile with a subsonic flight speed and a non-nuclear warhead (warhead). The new TSSAM (Tri-Service Stand-off Attack Missile) missile is designed to be launched outside of the

target air defense zone and is designed for use by the ground forces, the Air Force and the US Navy. The creation of two variants of the rocket is envisaged:

- AGM-137 - from the B-2, B-52 and F-16 aircraft of the Air Force, as well as from the A-6 and F / A-18 aircraft of the Navy;
- MGM-137 - from the MLRS launcher.

Both options have a range of up to 500 km and therefore should not be subject to existing arms reduction treaties. Airfields, open planes, air defense systems, command posts are considered as the main targets for AGM-137, and armored vehicles, including tanks, for MGM-137. In total, it is planned to purchase 8650 missiles of both types. The cost of creating and producing the specified number of missiles under the TSSAM program was originally $ 15.1 billion. A full-scale development phase is currently underway and the first successful tests of these missiles have been carried out.

In the summer of 1992 at the White Sands test site (New Mexico), flight tests were successfully completed to disengage warheads from a rocket flying at a speed of 540 m / s.

By 1992, MLRS / TGW expenditures totaled more than $ 540 million, with the US, which accounted for 40% of total expenditures under the contract, exceeded $ 230 million. In May 1992, the US Department of the Army stopped funding this program, which was caused by the need to reduce the cost of developing anti-tank warheads. In accordance with the requirement of the Congress, the command of the ground forces had to choose for further development one of three homing BEs, which were then at the technical design stage: TGSM, IRTGSM and BAT. It chose the latter.

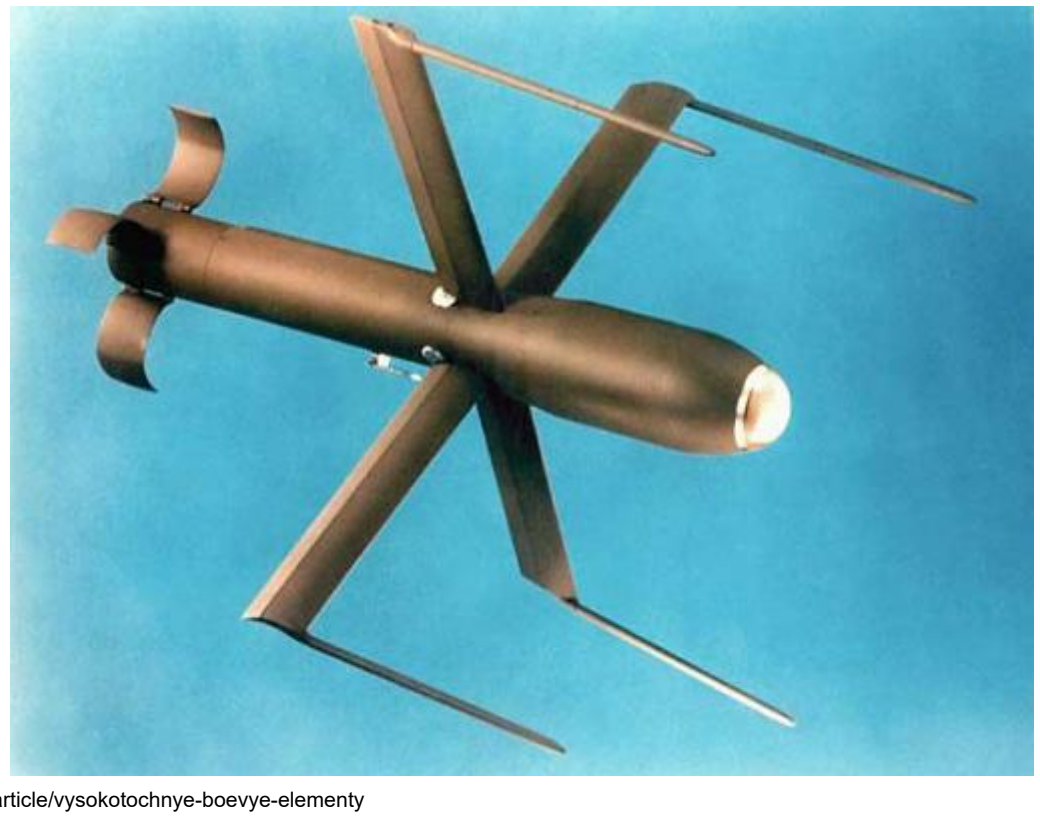
In December 1992, Germany, which provided 20% of the total funding, announced the termination of work on this program. This decision is connected both with an increase in the share of expenditures falling on each member of the alliance after the US withdraws, and with significant budget cuts for the development of so-called "heavy" anti-tank weapons systems.

The UK and France are looking for opportunities to continue their MLRS / TGW work on their own. So, in November 1992, the probable continuation of the research was announced at the parliamentary hearings on the budgetary financing of the French ground forces for 1993. Great Britain proposes to expand the number of variants of the use of TGSM-type BEs, using them in cluster warheads of promising aircraft anti-tank weapons systems of increased range. In addition, the British specialists do not exclude the possibility that work under the MLRS / TGW program will resume in the United States, but for now they can participate in them as a subcontractor. The deadlines for the current stage of work (technical design and demonstration tests) are almost a year behind the planned ones.

The next phase (full-scale development and qualification testing) will last about three years and will require US $ 312 million for the UK and France.

In connection with the withdrawal of the United States and Germany from the MLRS / TGW program, it is likely that the earlier planned dates for the start of production and delivery of the first TGW combat units to the troops, which were scheduled for 1996, will change. It is also possible that the development of the TGSM could be discontinued altogether.

BAT



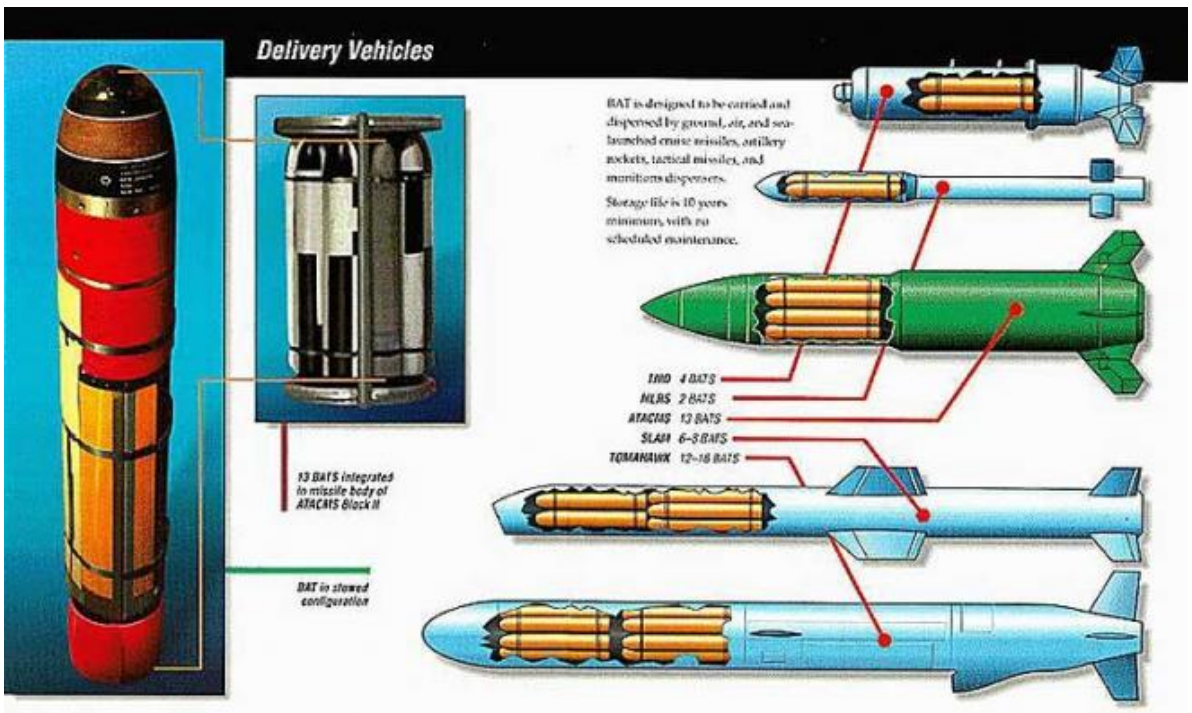
A cluster warhead equipped with a BAT element (Brilliant Anti-Tank) is considered as the main version of the head of the MGM-137 cruise missile. The general contractor is the Electronics Systems Division of Northrop Corporation and the main subcontractor is Raytheon. The cost of developing a cassette warhead, including large-scale production, according to experts, ranges from 2.2 to 2.9 billion dollars. Work on this program began in 1984, and by September 1991, $ 250 million had been spent.

The BAT element is built according to the normal aerodynamic design. It has a cylindrical hull with a drop-shaped thickening in the nose and developed aerodynamic surfaces: four rectangular folding wings in the central part of the hull and a four-element tail folding (twisted around the hull) stabilizer. The wings and stabilizer open after the deployment of the BE from the cassette warhead and provide its planning and slow rotation around the longitudinal axis. For effective destruction of promising tanks in a homing combat element, a shaped charge of a tandem type is used.

The search for enemy mobile groupings and target designation for the missile system is supposed to be carried out using the Jistars system. After the BAT element has been diluted over the target area, it functions autonomously, carrying out search, target recognition, homing and defeat.

VAT is equipped with a combined seeker as part of ultrasonic and IR target sensors. The dual-band IR target sensor is located in the nose of the aircraft, and the acoustic channel microphones are located in thin pins installed at the ends of the wings and protruding strongly forward. The result is an acoustic antenna array with four receivers and (due to its large wingspan) a sufficient measurement base.

On the cylindrical part of the body of the element (between the wings) there is a sensor of the system for measuring the parameters of the air flow, the knowledge of which allows you to solve the problem of noise reduction.



Earlier, acoustic guidance systems in anti-tank ammunition of this type were not used due to the high level of noise arising from the incoming air flow around them and the difficulties associated with ensuring the required target location accuracy during guidance. In this case, when creating an acoustic channel, the latest methods of processing acoustic signals, implemented in an onboard computer based on a microprocessor, were used, as well as design and technological solutions that allow starting the development and testing of acoustic sensors for homing warheads.

Although all foreign sources of information report the presence of two working channels in the seeker of the combat element, which differ significantly from each other in wavelength, they do not contain unambiguous information about the degree of integration of the sensors in the seeker. If at the initial stage of the flight, when searching for a target, only the acoustic channel works, then in the future, two algorithms for combining channels are possible.

In principle, the channels can work in parallel (then the target will be recognized by "summing" its features characteristic of each channel) or independently (then the channels will complement each other). Foreign experts believe that in BAT the practical implementation of the second variant of functioning of the combined seeker is most likely. Otherwise, a prerequisite for the possibility of detecting armored vehicles would be the presence of "hot spots" on the object and at the same time the noise of the tracks and the engine, that is, the target must be in motion or its engines must

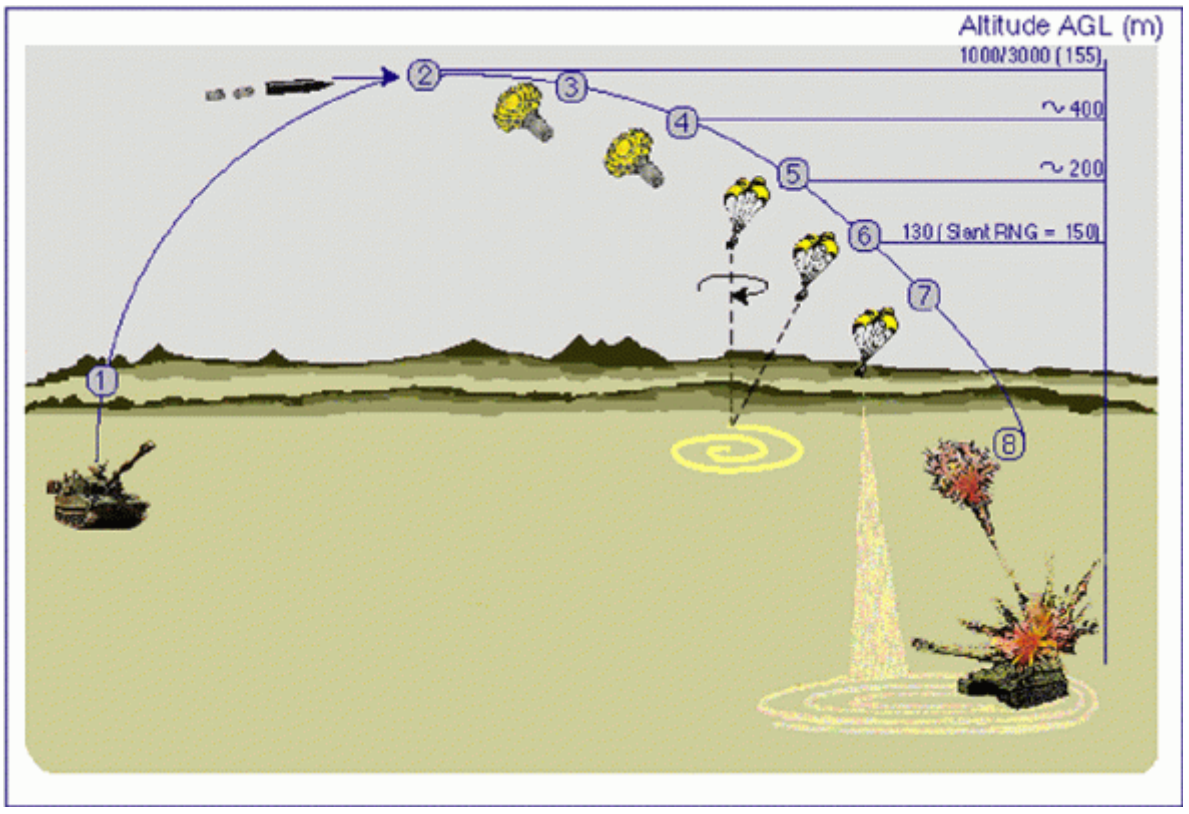
be idling. A number of field tests of the GOS were carried out to assess the possibility of detecting stationary and moving objects at the Navy training ground in China Lake (California). According to

representatives of the US Department of Defense, the tests were successful. BAT, with a mass of 20 kg, a length of 914 mm, a diameter of 140 mm, strikes targets in adverse weather conditions: with low clouds, strong winds and high dustiness of the atmosphere.

In accordance with the requirements of the US Congress on the need to reduce the cost of creating anti-tank submunitions by reducing the number of developments, the US Army chose BAT as the main equipment for equipping not only the MGM-137 missile, but also Block-2 mod.2 cluster warheads (for OTR ATACMS) and TGW cluster warheads (for MLRS MLRS).

An analysis of the effectiveness of the use of a cluster warhead with a combat element BAT, carried out by US Army specialists, confirmed the assumptions that it outperforms IRTGSM and TGSM in terms of cost / effectiveness. Its cost for a series of 10 thousand will be 17 thousand dollars (in 1992 prices). British military experts hold a completely opposite opinion about the prospects for using BAT, who believe that the TGSM is the most promising combat element for equipping various systems of cluster weapons.

SADARM



The SADARM self-aiming combat element was developed by the American firms "Aerojet" and "Alliant Techsystems".

This ammunition is intended for use with the M109A5 and M198 artillery systems. The SADARM combat element can be used in the warheads of ATACMS operational-tactical missiles, in the GBU-15 guided aerial bomb, in the AGM-130 guided aircraft missile and aviation cassettes, as well as for equipping cluster warheads for MLRS MLRS shells.

SADARM is designed to engage armored group targets at ranges up to 22 km and contains two self-aiming combat elements, each of which is equipped with a "strike core" warhead and a combined target sensor that includes passive IR and active-passive radar (millimeter wave) channels. The last channel is used in the same way as the altimeter. The parachute system provides a vertical descent of the element with a speed of up to 15 m / s and an inclination of 25-30 from the vertical. The projectile is fired into the area where the accumulation of armored vehicles is located, then at an altitude of about 750 m, the hull is opened and the cluster elements are ejected through the bottom. With the help of the braking device, the angular velocity of rotation of the element is extinguished, after which the belt parachute opens. SP BE in the process of descent using the target sensor scans the terrain in a spiral. When an object enters the field of view of the sensor, which turns on at an altitude of 150-200 m, its position is determined using a microprocessor and the warhead is detonated. The scanning area of the terrain with an initial height of 150 m is 18 thousand square meters. m.

The power of the SADARM warhead is sufficient to destroy self-propelled artillery and armored vehicles, its theoretical armor-piercing ability is sufficient to penetrate the upper part of the gun turret of most tanks, especially earlier models. The company "Aerojet" is implementing the R&D program to improve the SADARM SPBE. Its improved version should have higher performance characteristics and have a lower cost. Serial production of these SPBEs is planned for the 2002

financial year, and delivery to the artillery units of the ground forces is scheduled for 2003. According to foreign experts, the new combat elements will be characterized, first of all, by a higher

statistical probability of hitting (and, therefore, by a greater reliability of target detection and destruction). This can be achieved by making two relatively simple changes to the method of combat use and the design of the SPBE. First, it is necessary that he begins an active search for a target at a higher altitude (about 165 m). Secondly, the hovering angle of the SPBE relative to the autorotating parachute axis should be increased (up to 38 °), which will allow observing a large area. An improved version of this combat element will be equipped with a more powerful warhead, thus increasing the possibility of hitting targets of a high level of protection.

Initial testing of the SADARM revealed many problems. Today it is believed that these problems have largely been overcome. According to American experts, the SADARM combat element is one of the most promising.

BONUS

The 155-mm BONUS cluster projectile with the self-aiming warhead of the same name for engaging armored vehicles is being developed by Bofors Defense (Sweden) under a contract with the Armed Forces Logistics Directorate. Was released and its naval version, which is designed to use the 155 mm gun, which is being developed by the company "Giat" to destroy ground targets from warships in the framework of the theory of "coastal war".

To transfer SPBE type BONUS into autorotation mode and smooth descent, two small retractable wings are used. The aerodynamics of these wings provides angular stabilization with an inclination angle of 30-35 ° with respect to the vertical of the projectile. At a given height (up to 175 m), the altimeter sensor switches the on-board electronic equipment to the search mode. In the process of descent at a speed of up to 45 m / s, the SPBE sensor scans an area with an area of up to 32000 square meters, in which the target is located. When an airborne sensor detects and identifies a target, the submunition fires a “shock ball” warhead and strikes the selected target from above.

SPBE BONUS is designed to use only one IR self-aiming head (multiband, responding to electromagnetic radiation in several frequency ranges), which limits its use in adverse weather conditions. The Bofors Defense company has signed a contract with the French company BAE Systems for the revision and production of 11,000 IR sensors for BONUS projectiles. These sensors are formed by an array of six IR detectors based on a solid solution of cadmium and mercury tellurides.

The projectile uses a bottom gas generator, which provides a given firing range (up to 35 km) with a reduced mass of the propellant charge, which reduces the overload acting on the electronic unit of the element.

Since this development is somewhat ahead of those in other European countries in terms of timing, the firm hopes to receive additional orders. According to representatives of the Swedish Ministry of Defense, if the BONUS projectile is adopted for service, the programs for the development of artillery shells: the Art-Striks cluster and the BOSS guided missile may be canceled.

The prospect of the BONUS projectile is also evidenced by the fact that intensive negotiations have begun on joint refinement, production deployment and France's purchase of up to 30 thousand BONUS rounds. In accordance with the discussed agreement, the share of France is estimated at 254 million dollars.

354 million dollars.

In July 1998, the Swedish Defense Resources Administration (FMV) and the French General Directorate of Armaments (DGA) approved proposals to continue production of the BONUS self-aiming warhead. From the point of view of the American Securities and Exchange Commission, obtaining permission for the serial production of self-aiming warheads stimulated a considerable ($ 100 million) contract, which was signed by both companies.

The order for the serial supply of intelligent ammunition was legally formalized at a meeting of the board of directors of the Franco-Swedish consortium, which, according to foreign experts, allows us to hope for compliance with the work schedule and other key parameters of the program of both FMV and DGA. In particular, the order (at least a significant part of it) was scheduled to be completed in 1999. At the end of the year, Bofors Defense and GIAT held intensive consultations with potential customers of the BONUS self-aiming combat element, who showed an increased interest in new generation artillery ammunition.

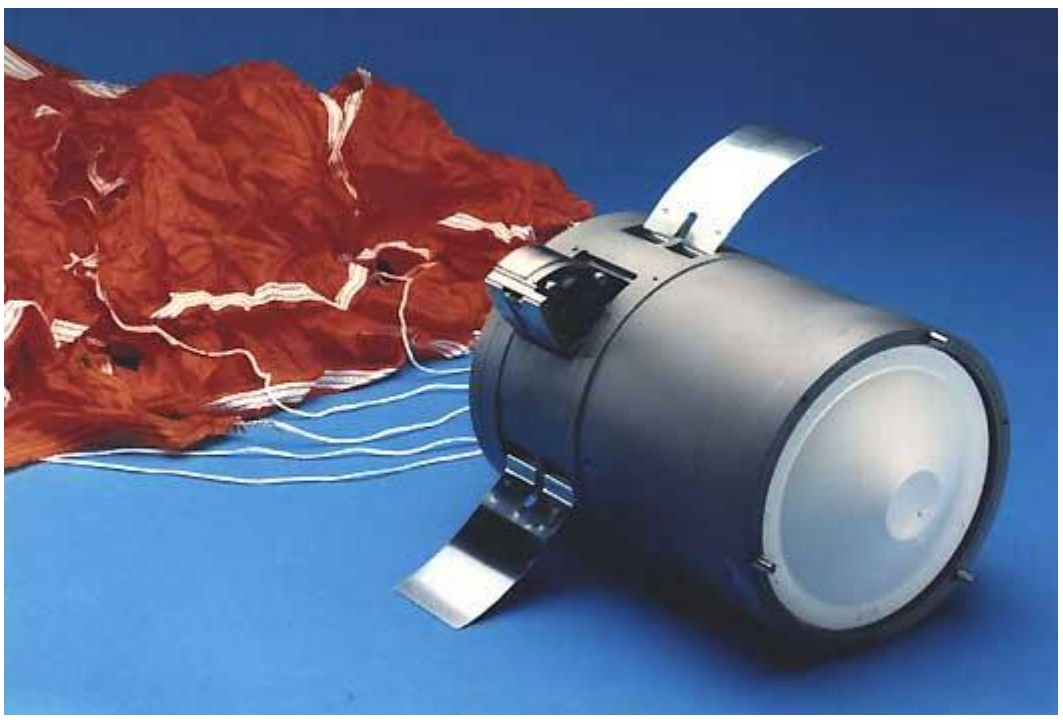
Tests of BONUS showed its rather high efficiency: a salvo of 36 such shells within 15 seconds hit six of 18 tanks located on an area of 600x600 m.

ACED

The 155-mm TACED cluster projectile with three self-aiming submunitions (recently this development was called ACED in periodicals) has been created in France since the early 80s by the GIAT association and Thomson-Brandt on the instructions of the command of the ground forces. The conceptual development stage was completed in 1989, which allowed Thomson-Brandt to present the ACED projectile at the Satori-90 weapons exhibition.

In 1991, firing tests of a projectile with three inert elements were successfully completed, which made it possible to move on to full-scale development. The choice of the design and layout of the projectile and combat elements has not yet been completed, and its demonstration tests can actually begin only in a few years. In order to accelerate the development and use of the experience of creating the SMArt-155 projectile, the German companies "Diehl" and "Rheinmetall" were invited to participate in the ACED program in 1992.

SMArt



The 155-mm SMArt-155 cluster projectile (Suchzunder-Munition fur die Artillerie-155) and the self-aiming warhead of the same name were developed in Germany by the GIWS consortium (it includes Diehl and Rheinmetall).

The SPBE projectile SMArt-155 has three target indication sensors (a miniature radar operating on the principles of both passive and active location, as well as an infrared detector). The sensors function simultaneously, and a generalized target image is formed at the output of the measuring system. For reliability, the signals taken from the sensors are processed by the processorusing two special scanning algorithms, which allows SPBE not to react to false targets. In the foreign press about these algorithms it is said that it is on the basis of the IR sensor signals that the main (thermal) image of the target is synthesized. Active and passive millimeter-wave radar sensors form an alternative self-aiming channel, sensitive to the target's metal sheathing, as well as to the reinforced concrete floors of engineering structures.

The necessary R&D and preparation of production facilities for the transition to serial production were completed in mid-1996. In the second half of the same year, a "significant amount" of this ammunition was placed at the disposal of the German Federal Office for Defense Technology and Arms Purchase (BWB). The special commission of the Bundeswehr recognized the results of the range tests for the maximum range as successful and recommended that this combat element be adopted by the ground forces. The Bundeswehr also defined a program for the production of these shells (until 2003), according to which the need for them by the ground forces is 88 thousand combat and 18 thousand training. The total cost of work under the program will amount to 2.5 billion marks.

By the end of 1998, about 1,500 new ammunition had been tested (including 100 fully equipped self-targeting submunitions and 800 warheads). In addition, computer simulations and field tests of individual subsystems and blocks of self-aiming combat elements were carried out many times. Particular attention was paid to the reliability of the operation of onboard high-sensitivity sensors in the process of searching for camouflaged targets and active countermeasures by the enemy (on terrain with different terrain and in any climatic zones).

The first experimental batch of new ammunition was released in early 1999, and the decision to switch to full-scale production was made in August of the same year. The new SMArt-155 ammunition is delivered primarily to artillery units armed with PzH-2000 self-propelled howitzers with a 52-caliber barrel, allowing firing at a range of up to 28 km.

According to Western press reports, the leadership of the United States Air Force became interested in a projectile with self-aiming combat elements of the SMArt type. Already in July 1997, the air navigation systems control center (Eglin airbase) included special points in the contract for the technological development and launch of these self-aiming combat elements into a series.

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